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DEVELOPMENT OF A RASTER SCANNER AND COLOR SEPARATION SYSTEM (SC--ETC(U)
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The SCI-TEX Response 200 System is used for color separating patterns and floral designs in the textile industry. Tests showed that the system could scan several colors and that the digitized data could be edited, altered, and enhanced. In addition, the machine, with restrictions, can scan colored areas as large as a square yard. With this knowledge, a newer model, the SCI-TEX Response 250 Cartographic System, was developed with larger storage and better scanning capabilities. Three examples of in-house production are discussed and analyzed. CONT'

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CONT

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DEVELOPMENT OF A RASTER SCANNER AND COLOR SEPARATION SYSTEM (SCI-TEX RESPONSE 250 CARTOGRAPHIC SYSTEM)*

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BIOGRAPHICAL SKETCH

Donald Wirak has a B.S. degree in Geography from the University of Maryland. In his work at the U.S. Navy Oceanographic Office he worked with computer applications for graticules, point plots, and electronic navigation systems. He has participated in ocean surveys and has extensive experience in compilation of nautical charts. He is now a senior cartographer in the Hydrographic Contract Branch of the Defense Mapping Agency Hydrographic/Topographic Center (DMAHTC) and is responsible for preparing, inspecting, and releasing for printing cartographic compilations done by private contractors and government agencies. On a special team he tested the SCI-TEX Response 200 System for cartographic applications.

ABSTRACT

The SCI-TEX Response 200 System is used for color separating patterns and floral designs in the textile industry. Tests showed that the system could scan several colors and that the digitized data could be edited, altered, and enhanced. In addition, the machine, with restrictions, can scan colored areas as large as a square yard. With this knowledge, a newer model, the SCI-TEX Response 250 Cartographic System, was developed with larger storage and better scanning capabilities. Three examples of in-house production are discussed and analyzed.

This paper was written from the cartographic color separation veiwpoint. Another paper, "Chart Modification and Reproduction with a Raster System," presented at this convention by Mr. Jan Schneier, was written from an equipment operations viewpoint.

INTRODUCTION

The Defense Mapping Agency Hydrographic/Topographic Center (DMAHTC) has agreements with certain foreign countries whereby nautical charts produced by foreign countries can be reproduced. These agreements save research and compilation time for the cooperating countries.

When making reproductions from multicolored printed maps or charts, color separation has generally been accomplished by photographing the copy through filters. However, difficulties have been encountered with filtering out yellow, brown, and red, and features printed in these colors may appear on more than one plate. Consequently, these overlapping colors have to be separated by engraving and drafting methods. Optical scanners separate colors but tend to confuse them, add noise, and create halos around cartographic detail. The new generation of optical scanners use fourth-generation computers to solve the scanning problems and to automatically edit out unwanted noise, specks, halos, and colors. This paper is a discussion and analysis of production from such a system, the SCI-TEX Response 250 Cartographic System. It is projected that this system can significantly speed up the production cycle to reproduce foreign charts.

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*Any mention herein of a commercial product does not constitute endorsement by the U.S. Government.

TEXTILE APPLICATION BACKGROUND

Before the development of the SCI-TEX Response 250 Cartographic System and when the SCI-TEX Response 200 System was the principal line, the main customers of SCI-TEX were textile firms involved in lithography work. Textile lithography is similar to cartographic lithography. Draftsmen and lithographers are employed in both industries to make open window negatives and opaque negatives suitable for printing. The final negatives must be true to size for the textile industry to insure that the negative patterns fit exactly around large copper coated print rollers. The ends of the negatives must match exactly so that a seam is not apparent on the continuous printing of the pattern on cloth. Because SCI-TEX had to meet the stringent requirements of their textile customers, they developed a raster color separation system that had potential for cartographic color separation. Textile lithographers scanned small areas (1 square foot) which the older system handled well. After the editing was finished, the pattern during film exposure would be repeated, thus filling a film sheet, 42- by 75-inches maximum size. The scanning of small areas was a limiting factor for cartography because maps and charts encompass areas from 4 to 16 square feet. However, the SCI-TEX Response 200 System had potential for cartographic use.

CARTOGRAPHIC POTENTIAL

Tests showed that the SCI-TEX Response 200 System can scan many colors from small sources and can scan two colors from sources larger than a square yard; though the scanning for two colors from large sources has restrictions due to limited disc storage and software capability. In addition, a scanned image can be changed, altered, and enhanced. These editing capabilities are diverse. Revisions can be done at the edit station by entering commands on a keyboard and by pointing with a stylus to specific areas to be changed. The whole digitized image can be enhanced by entering commands on the command console. The 36- by 36-inch scanning capability was a limit to nautical charts; however, the oversized charts can be scanned in two halves and the halves rejoined on the plotter by butting the edges together. This was done by analytically positioning the two halves on the film during exposure on the laser plotter. The laser plotter, within a 42- by 75-inch capacity, can generate a final product of any size that is needed by DMAHTC. With this knowledge a new model, the SCI-TEX Response 250 Cartographic System, was ordered and developed with two Hewlett-Packard 21 MXE minicomputers, more disc storage, better scanning capability, and software adapted to cartographic needs.

THE SYSTEM

The SCI-TEX Response 250 Cartographic System is a raster image processing system which scans an image by use of an optical scanner, digitizes the image scanned, digitally modifies the image according to commands, and generates exposed film of desired sizes by the use of a laser plotter. The system has five main elements:

1. The scanner.
2. The color-design console, referred to in this paper as "edit station" where operator-assisted edit functions are performed.
3. The plotter, a laser film-exposing device that produces the final product.
4. The command console, where automatic computer commands are entered to control the functioning of the system.
5. The computers which control the scanner, edit station, plotter, and command console. The computers are Hewlett-Packard 21 MXE minicomputers.

Because the 250 has a dual capability (being able to do two functions at once), the system has two computers.

To understand the operation of the SCI-TEX Response 250 Cartographic System, the functions of the first three elements (scanner, edit station, and plotter) are described below:

Scanner - The scanner receives reflected light (like a color television camera) and automatically digitizes what is sensed. The scanner can perceive up to 12 colors. Varied maps and charts of different colors can, thus, be scanned and digitized. The scanner works best with lines, contours, culture, and type.

Edit Station - The edit station reads digitized visual information from a disc as needed. Sections of a chart or map appear enlarged on a color television screen. The digitized detail on the screen can be deleted, strengthened, added to, and changed by keyboard entry and by pointing with a stylus to a specific area.

Plotter - The laser plotter is used after the editing is completed to generate exposed films of the separated colors. The exposed films are then developed in a darkroom. The laser plotter can handle film sizes up to 42 by 75 inches.

INITIAL PRODUCTION AND DEVELOPMENT

The three examples discussed and analyzed in this paper are charts that have been color separated by the SCI-TEX Response 250 Cartographic System. Later, the color separated charts will be modified by compiling, drafting, and adding border type, notes, translations, updates, and the chart number. The resulting charts will be printed by DMAHTC. The foreign sources are multicolored printed charts with 3 to 5 colors. The initial production, of which these three examples are a part, depended on the willingness of cartographers not to demand a complete product from the SCI-TEX. However, in the future, an almost complete product will be produced; already, standard border notes can be added using the edit stations and library of notes and symbols.

The first example is Japanese chart 1191; a chart consisting of two equal-size plans, and measuring 38 inches north-south and 28 inches east-west. There are three colors to separate: the black base, the light buff land tint, and a few orange light discs. This example is the simplest kind of color separation for which the SCI-TEX 250 is used. The black and orange were calibrated as separate colors. The light buff and white chart paper were calibrated as the same color, giving an average reading that was scanned as one color. This calibration of the colors to be scanned and the colors to be averaged in with the paper background took 30 minutes of operator time. However, the scanning time is completely automatic and needs no operator assistance. The scanning took (in this example) twice as long as a sample within the 36-inch length prescribed scan size. For this 38-inch long chart, the scanner scanned one line on the first rotation and on the next rotation positioned the scanning head for scanning the next line. However, scanning lengths less than 36 inches give the head enough time to scan on each rotation. The scan took 7 hours for this oversized chart. After the scan, the detail was viewed in the edit station television screen. A black halo was evident around the orange detail. The halos were erased by being blended into the orange detail by the command "frame." However, the command also trimmed some of the black detail around the buoys that were overprinted by the orange discs. The command "frame" was the only editing that was done on this chart and the editing time was 20 minutes. The final stage was exposing the black detail on the plotter which took only 20 minutes. The final product was a 26- by 38-inch positive of the black detail. The orange was not needed; instead, a new drafted original replaced the light discs with flares. The land tint was recreated by using the dri-strip method of making windows; the buff tint was too light to easily separate from the white paper background. In this simple example the machine is less efficient than the use of the camera and drafting. However, as the examples become more complex the machine surpasses the manual methods in efficiency and productivity.

The second example is Japanese chart 134B, which is 19 inches north-south and 26 inches east-west. The chart is within the square yard size that is best scanned by the SCI-TEX system. The chart has three colors: black base, light buff land tint, and a few purple light flares. Since all three colors were needed, the procedure used for this second example was more thorough and required more operator, edit, and Response 250 System time. The black, purple, and the black-purple overprints were calibrated as separate colors. The light buff and white chart paper were calibrated as the same color giving an average reading that is scanned as one color. The calibration time took 1 hour and the scanning for the 20-inch-wide chart was 3 hours. After the scan, the detail was viewed in the edit station; a black halo was noted around the purple detail. As in the first example, the black was blended into the purple by the command "frame." Because of the calibration of the black-purple overprint as a separate color, the black detail within the purple areas was retained rather than trimmed as in the first example. Scanning overlapping colors as a separate color is an easy way to ensure that gaps are not left where black overprints purple (or any other color that may be scanned). A deletion guide (on acetate overlay) was marked in yellow for areas of black and purple detail to be deleted. This deleting was done by selecting the background color on the edit station keyboard and drawing the color over the unwanted detail with a stylus. The land tint was generated in the edit station by a keyboard entry "computer fill" and touching with a stylus the area to be filled. The time needed for these three edit procedures—purging unwanted halos, omitting unwanted detail, and editing in land detail—took 5 hours. Three film positives were exposed: the black plate showing the black and black-purple overprint, the purple showing the purple and the black-purple overprint, and the land tint plate showing a fourth color that was generated by editing at the edit station. The film exposing took 1½ hours. This chart was almost completed except for placing the necessary type for the black and purple plates. However, due to the rapid change that must be accounted for in nautical charting, there was a 4- by 4-inch correction which was inserted by hand at the last minute. This problem of new information, such as new editions making work obsolete, must be expected. When a new edition is required (which is often the case with Japanese charts), a new scan, edit, and film exposures have to be made. The following table compares the SCI-TEX system against conventional methods of color separating Japanese chart 134B.

SCI-TEX		Conventional (Manual)	
Manual Function	Hours	Function	Hours
Calibration	1	Camera	½
Manual Editing	5	Film Developing	½
Film Developing	½	Drafting	2
Manual Total	6½	Manual Total	3
Automatic Functions			
Scanning	3		
Film Exposures	1½		
Automatic Total	4½		

This second example with more editing does not compare as well with conventional methods of color separation but in this example all the work is done digitally within the SCI-TEX system; this shows the potential of using the SCI-TEX as an automatic digitizer. Discrepancies such as broken lines can be corrected by editing.

The third example is British Admiralty chart 1977, which is 41 inches east-west and 26 inches north-south. The chart is of North Wales, Great Britain, and has many light flares, traffic zones, cables, notes in purple, and a 36-square inch screened area. The black detail is unusually dense for nautical charts with many contours, towns, roads, place names, and notes. The land tint is dark yellow, the foreshore area is olive green and the water has a blue area to the 5-meter curve and a blue ribbon inside the 10-meter curve. The black, purple, dark yellow, olive green, and blue were calibrated and scanned as separate colors. It was easier in this case to scan all of the colors and later generate films of the black and purple colors. The scanning of all five colors in this case eliminated halos completely. However, where the black overprinted the purple there was a gap left in the purple. Manual drafting can restore the gaps in the purple detail. The gaps can be filled by the edit station with 4 hours of machine time but drafting takes only 1 hour to replace and touch up gaps. This is a case in which hand methods can be used to augment and expedite the automatic color separation. The scanning of the overlap areas in this case made the system choose the wrong colors for what was sensed; the black-purple overlap areas matched other colors too closely, creating erroneous data. Often when operators demand fine differentiation between colors with overprints scanned as well, colors are exchanged and merged in areas due to the scanner being used beyond its capability. The calibration took 1 hour because several calibrations and test scans were made before satisfactory imagery resulted. The chart had to be scanned in two separate equal halves. The two separate scans took 8 hours. Since the calibration was done carefully and the plates were not being improved by the system, hardly any edit time was needed. The two halves were butted by generating the first half on unexposed film and by computing the origin of the next half analytically so that it would butt against the other half. Thus, the whole chart was generated on one sheet of film. However, the two halves had to be adjusted lengthwise and widthwise to match exactly and to be the exact correct scale and size. Simple proportions computed were entered in the command console for each half regenerated to produce the final black plate and purple plate. This correct-size film production took 3 hours. The following table compares the SCI-TEX system with manual drafting against conventional methods and against the use of the SCI-TEX system exclusively.

SCI-TEX and Drafting		Conventional (Manual)		SCI-TEX Only	
Manual Time	Hours	Task	Hours	Manual Time	Hours
Calibration	1	Camera	½	Calibration	1
Drafting	2	Film Developing	½	Editing	8
Editing	4	Ordering Type	2	Film Developing	½
Film Developing	½	Drafting Purple	6		
		Removing Unwanted			
Manual Total	7½	purple composed		Manual Total	10½
		with black	4		
Automatic Time		Reconstructing		Automatic Time	
		black in screened			
Scanning	8	areas	16	Scanning	8
Film Exposures	3			Film Exposures	3
Automatic Total	11	Manual Total	29	Automatic Total	11

This third example with 2 hours of drafting (conventional methods) and 5 hours of operator time, the SCI-TEX requires 21½ hours less of manual labor than the conventional method of color separation and 3 hours less of manual labor than the exclusive use of the SCI-TEX system. This is a good illustration that the judicious use of manual labor can make automation more efficient. It should be noted that the SCI-TEX Response 250 Cartographic System can do two functions such as scanning, editing, or film production at any one time; this enables operators to color separate two maps at once by doing two functions at a time.

CONCLUSION

From the three examples which were presented in the same order as they were done on the SCI-TEX 250 System, one can see the degree of difficulty increase and the quality of the color separation improve. This factor of increased difficulty of work with improved quality is the result of operators improving their skill with practice and experience. Another factor is that machine time can be traded for completeness of product. Often hand corrections are faster and more efficient than lengthy editing. As has been proven in past tests, such as the third example (3 hours of SCI-TEX system time saved), a wise combination of system time and manual time expedites production as compared to the same production completely done by the SCI-TEX System or production completely done by manual processes. In the future as the library is enlarged with standard notes and symbols and with increasing operator experience, extensive operator-assisted compiling at edit stations will produce a more complete product. Already standard border notes can be added using the edit station and the library of notes and symbols. All changes of notes and symbols must be reentered in the library, all repositioning and format changes must be recomputed analytically, and all compilation procedure changes require changing edit procedures; therefore, cartographers must take care in writing specifications so that in the future corrective changes will not have to be made. This factor of unnecessary changes slowing down production is true with all automation as well as with raster scanning and color separation.

However, with good judgment, stable procedures, consistent standards, and the avoidance of unnecessary editing, production at DMAHTC has been improved. With these factors in mind the SCI-TEX Response 250 Cartographic System will produce many color separations and compilations for the cartographic community in the same manner that its predecessor the SCI-TEX Response 200 System has produced final open windows in volume and quality for the textile industry.

ILLUSTRATIONS - Donald Wirak Paper

(In Work - no copies furnished)

Sci-Tex Response 250 Cartographic System

Scanner
Edit Station
Laser Plotter

In manufacturer's literature and in System diagram previously cleared in Jan Schnier's paper, DMA Case #79-125

Three charts

Japanese Chart 1191
Japanese Chart 134B
British Admiralty Chart 1977

On public sale

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11 December 1979